AE4010 – Research Methodology

Research Methods

Planning... but planning what?

6. Planning
Planning... but planning what?

1. To finish!
2. To deliver what you agreed!
3. To work at the highest academic level!
4. To get a good mark!
5. To achieve something worthwhile of value!
1. Finish on time!
Plan to finish within the timescale given, considering resources, risks and concurrent time allocation to tasks!
The more complicated, the more planning required, but keep it manageable, time increments in particular!
2. Deliver what you agreed!
6. Research Methods

Delivering to:

• supervisor:
  • Models
  • Tools
  • Lit. review
  • MON
  • Reports/presentations
  • Papers
  • Data sets...

• collaborating company:
  • Solutions
  • Computer tools
  • Rules
  • Presentations & manuals
3. Work at the highest academic level of achievement!
So, in terms of modelling real research problems:

"As far as the laws of mathematics refer to reality, they are not certain; as far as they are certain, they do not refer to reality."

Albert Einstein
Recap!

• The scientific method is a way to ask and answer scientific questions by making observations and doing experiments.

• The steps of the scientific method are to:
  • Ask a Question
  • Do Background Research
  • Construct a Hypothesis
  • Test Your Hypothesis by Doing an Experiment
  • Analyze Your Data and Draw a Conclusion
  • Communicate Your Results

• It is important for your engineering experiment to be a fair test. A "fair test" occurs when you ‘TRY’ to change only one factor (variable) and keep all other conditions the same.

• While scientists study how nature works, engineers use this to create new things, such as products, websites, environments, and experiences; realize the overlap!
Overview of the Scientific Method

• The scientific method is a process for experimentation that is used to explore observations and answer questions. Scientists use the scientific method to search for cause and effect relationships in nature. In other words, they design an experiment so that changes to one item cause something else to vary in a predictable way.

• Just as it does for a professional scientist, the scientific method will help you to focus your science fair project question, construct a hypothesis, design, execute, and evaluate your experiment.

• All of this is applied research and ultimately the purists would call it operational research (from a scientific perspective).
Such as!
Or moving to 9 steps – even better?
Steps of the Scientific Method: 1

- **Ask a Question**: The scientific method starts when you ask a question about something that you observe: How, What, When, Who, Which, Why, or Where?

- And, in order for the scientific method to answer the question it must be about something that you can measure, must be with a number in the engineering context!
Steps of the Scientific Method: 2

- **Do Background Research:** Rather than starting from scratch in putting together a plan for answering your question, you want to be a savvy scientist using library and Internet research to help you find the best way to do things and insure that you don't repeat mistakes from the past. Live and learn!
Steps of the Scientific Method: 3

• **Construct a Hypothesis:** A hypothesis is an educated guess about how things work:

  "If _____[I do this] ______, then_____[this]______ will happen."

• You must state your hypothesis in a way that you can easily measure, and of course, your hypothesis should be constructed in a way to help you answer your original question.
Steps of the Scientific Method: 4

• **Test Your Hypothesis by Doing an Experiment:** Your experiment tests whether your hypothesis is true or false. It is important for your experiment to be a fair test. You conduct a fair test by making sure that you change only one factor at a time while keeping all other conditions the same.

• You should also repeat your experiments several times to make sure that the first results weren't just an accident.
Steps of the Scientific Method: 5

• **Analyze Your Data and Draw a Conclusion:** Once your experiment is complete, you collect your measurements and analyze them to see if your hypothesis is true or false.
• Scientists often find that their hypothesis was false, and in such cases they will construct a new hypothesis starting the entire process of the scientific method over again. Even if they find that their hypothesis was true, they may want to test it again in a new way.
Steps of the Scientific Method: 6

- **Communicate Your Results:** To complete your MSc thesis you will formally communicate your results to others in some form of a final report and for the best, in an academic conference or journal paper. All professional scientists and researchers do exactly the same by publishing their final report in a scientific journal or by presenting their results in a conference presentation/paper or on a poster.

- TUD students have the added oral presentation to exam members, faculty members, peers and friends & family.
So observe, record, analyse and report!

- Even though we show the scientific method as a series of steps, keep in mind that new information or thinking might cause a scientist to back up and repeat steps at any point during the process. A process like the scientific method that involves such backing up and repeating is called an iterative process.

- Throughout the process of doing your MSc you should keep a record containing all of your important ideas and information; bits of observation, analysis insight and ultimate knowledge which only the most special researchers do (5%?).
And therefore the question becomes: NOW for ME at TUD in my MSC:

“What can I do to build realistic models for engineering reality?”
Don't follow your dreams; chase them

Richard Dumb
The future of aviation can only be guaranteed through a sustained scientific research approach to the required research innovations, in order to deliver an optimal value system that addresses sustainable function, cost and customer satisfaction!
What are you willing to sacrifice to meet the research challenges identified by your Professor? How much do you want to make a real difference, rather than just playing it safe and getting through?
4. To get a high mark!
To achieve a high mark:

- Do something new and innovative
- Have a strong theoretical basis
- Establish the viability prior to the mid-term
- Be very critical of your theoretical assumptions and subsequent findings
- Verify your work at whatever level possible
- Validate your models if possible
- Ask your supervisor how your work could improve
- Ask yourself if it is publishable?
- Write a draft of the results chapter at least 2 months before the end
- Keep your thesis concise, insightful and clear, and highlight the main elements
- Have fewer main points than numerous ‘interesting’ points!
- Etc., proof read it, be critical, be reflective!
5. Prepare
Literature Review

- Divide your initial search up into keywords associated with your hypothesis (specific theory, particular application, wider topic, general field, supporting general theory, etc)

- Search on higher quality search machines such as Webster, ISI rated, professional organizations (AIAA, RAeS, etc), google scholar, etc.

- Read abstract, scan paper and get ones that seem to be promising. Look at references in best papers to use their references, up-to-date being most important!

- Write a simple line of what the paper’s main contribution is and then you can group a number of papers into a block that you can use to explore the state-of-the-art in a certain area.

- Always summarize or synthesize at the end at least in order to add your interpretation clearly, while also linking it you your research hypothesis and objectives.
Global Planning!

6. Research Methods
Keep your eye on the ball!

- What is the research question?
- What is the hypothesis to test?
- What do I need to deliver?
- How is my timing?
- What can I improve?
- Do I still time at the end to reflect and improve, or is it on the edge?
6. Do something worthwhile of real value!
6. Research Methods